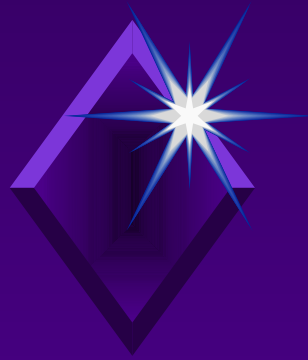


The background of the slide is a photograph of a sky. In the upper left, a bright sun or moon is partially obscured by a large, billowing white cloud. A vibrant rainbow arches across the sky, its colors appearing as soft, glowing bands. The rest of the sky is filled with various cloud formations, some wispy and others more dense. The overall lighting is bright, suggesting a clear day despite the cloud cover.

Tropical Cyclones



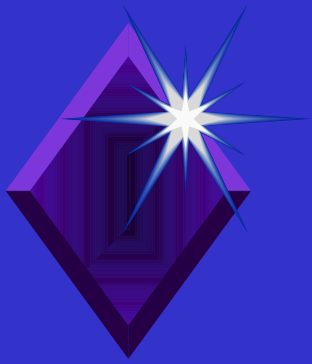
TROPICAL CYCLONES OVERVIEW

- ◆ **TROPICAL CYCLONE FORMATION AND DEVELOPMENT**
- ◆ **TROPICAL CYCLONE CHARACTERISTICS**
- ◆ **CONDITIONS OF READINESS**
- ◆ **STORM TRACKS**



TROPICAL CYCLONES OVERVIEW

- ◆ **MONITORING THE STORM**
- ◆ **TROPICAL CYCLONE WARNINGS**
- ◆ **TROPICAL CYCLONE EVASION**

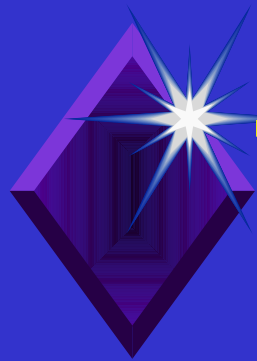


JTWC:

- **Bible is USCINCPACINST 3**
Tropical Cyclone Operation

Messages:

- **TCFA: Tropical Cyclone Formation Alert**
Advises of an area with the potential for
into a significant tropical cyclone.
- **Tropical Cyclone Warning: provides location,**
intensity, size, and movement.
- **ABPW10 PGTW: Western Pacific Significant**
Weather.
- **WHPN PHNC: Eastern North Pacific Area**
- **WTPN PGTW: Western North Pacific Area**



TROPICAL CYCLONE AOR

NHC: covers out to 140W.

**Central Pacific Hurricane Center: cen
Hawaii. AOR covers 140W to 180W.**

**JTWC/NPMOC: covers west of 180. Pu
out TCFA's for entire Pacific.**

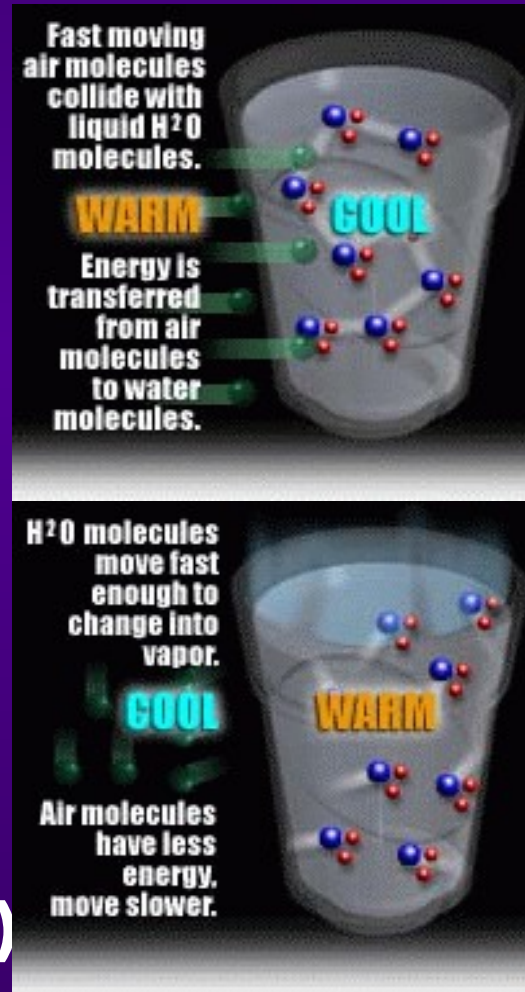
NPMOC Yoko: backup for JTWC



TROPICAL CYCLONE FORMATION

Conditions Required for Formation

- ◆ SST > 78 F
- ◆ low level winds converging (8-20N, ITCZ)
- ◆ organized convection (disturbance) - latent heat
- ◆ disturbance moving less than 13 kts (easterly waves, etc...)
- ◆ Upper Level outflow (divergence)

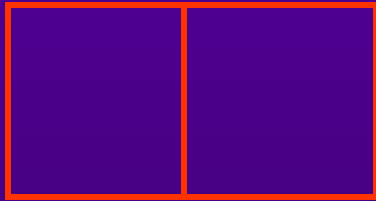




TROPICAL CYCLONE

Stages of Development

**1. Tropical Cyclone
Tropical Storm
Formation Alert**



**2. Tropical Depression
Hurricane**

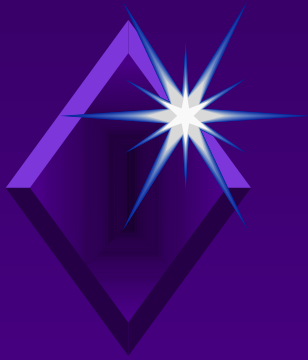


3.



4.

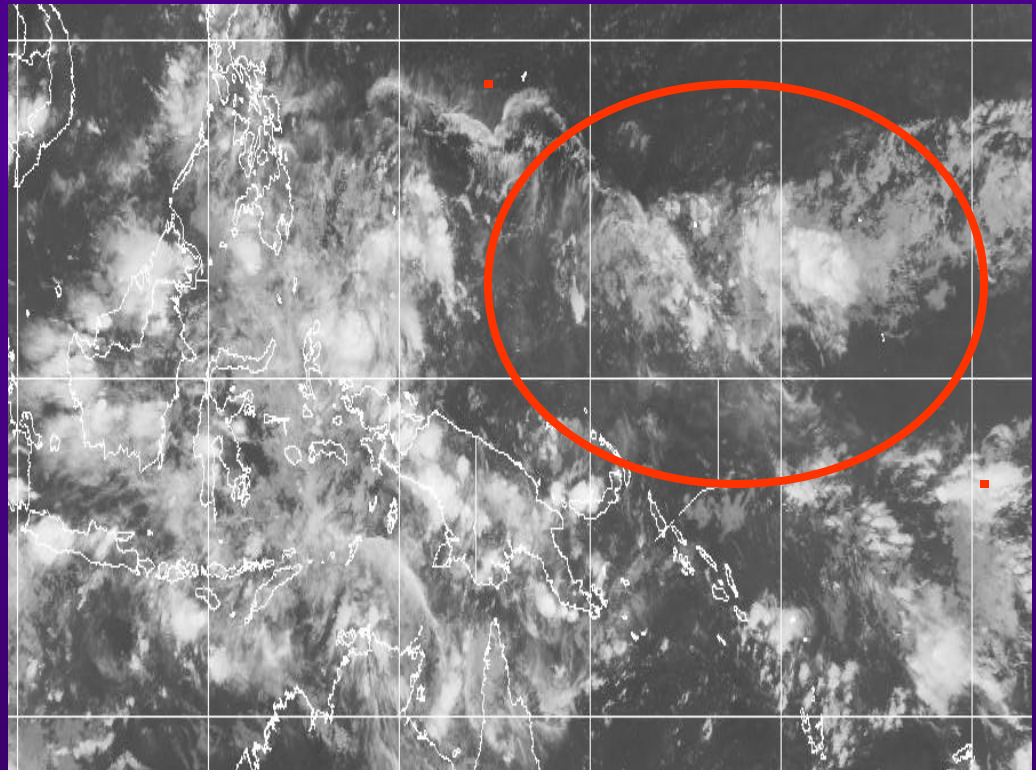


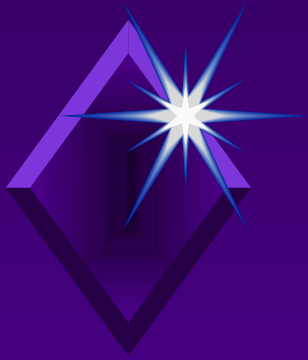


TROPICAL CYCLONE FORMATION ALERT

TROPICAL CYCLONE FORMATION ALERT (TCFA)

- ◆ **no significant winds or seas**
- ◆ **no defined surface circulation**
- ◆ **valid for 24 hrs**

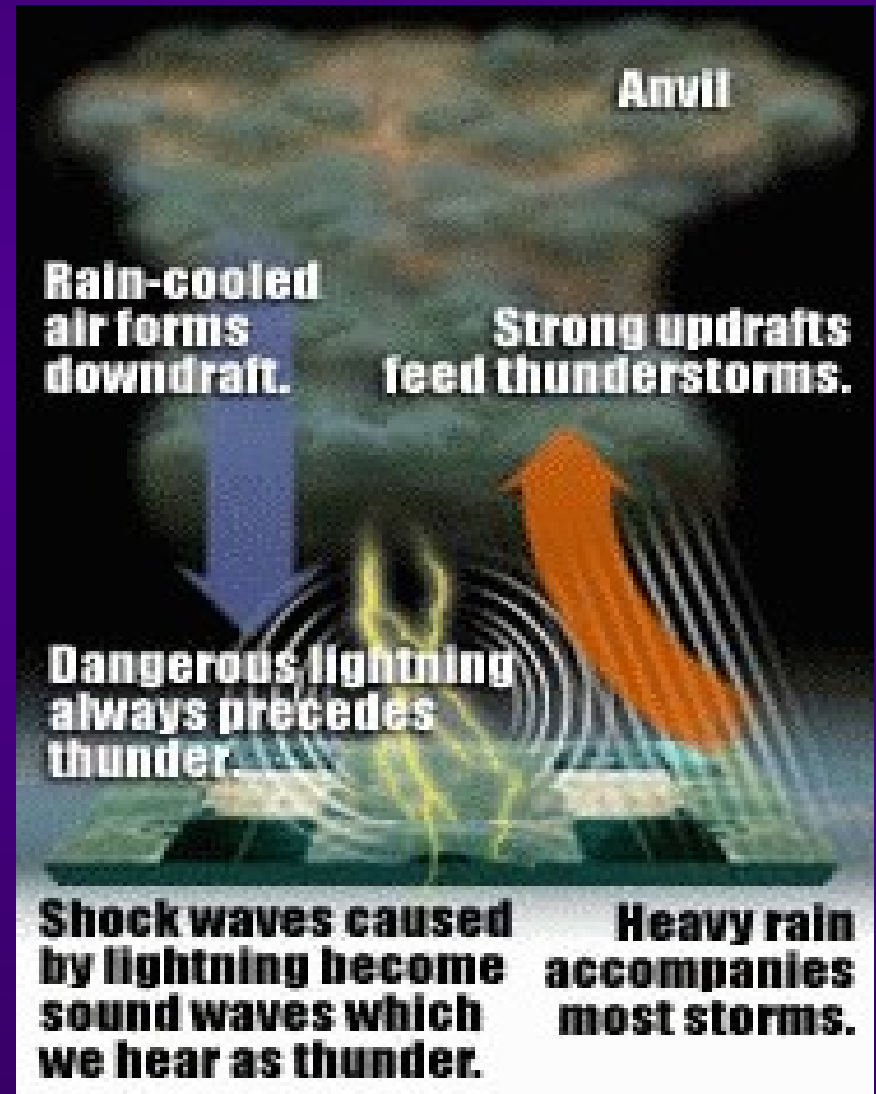


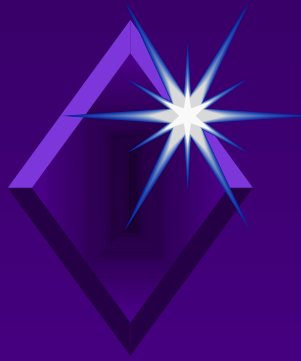


TROPICAL CYCLONE FORMATION ALERT

- ◆ **identified by areas of convergence (thunderstorms) on surface charts and satellite imagery**

- ◆ **issued by JTWC/NPMOC**

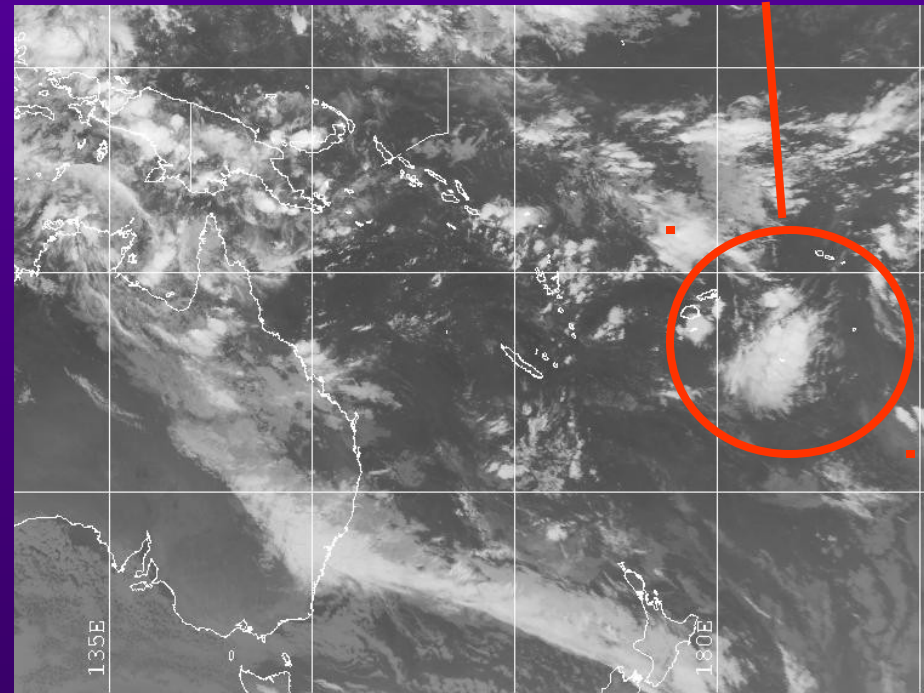




TROPICAL DEPRESSION *(Formative Stage)*

- ◆ winds < 33 kts
- ◆ tropical wave develops a **weak cyclonic circulation**
- ◆ identified by **thickening clusters of tstms** on satellite
- ◆ central **pressure falls rapidly** below 1002mb if system intensifies

TROPICAL DEPRESSION

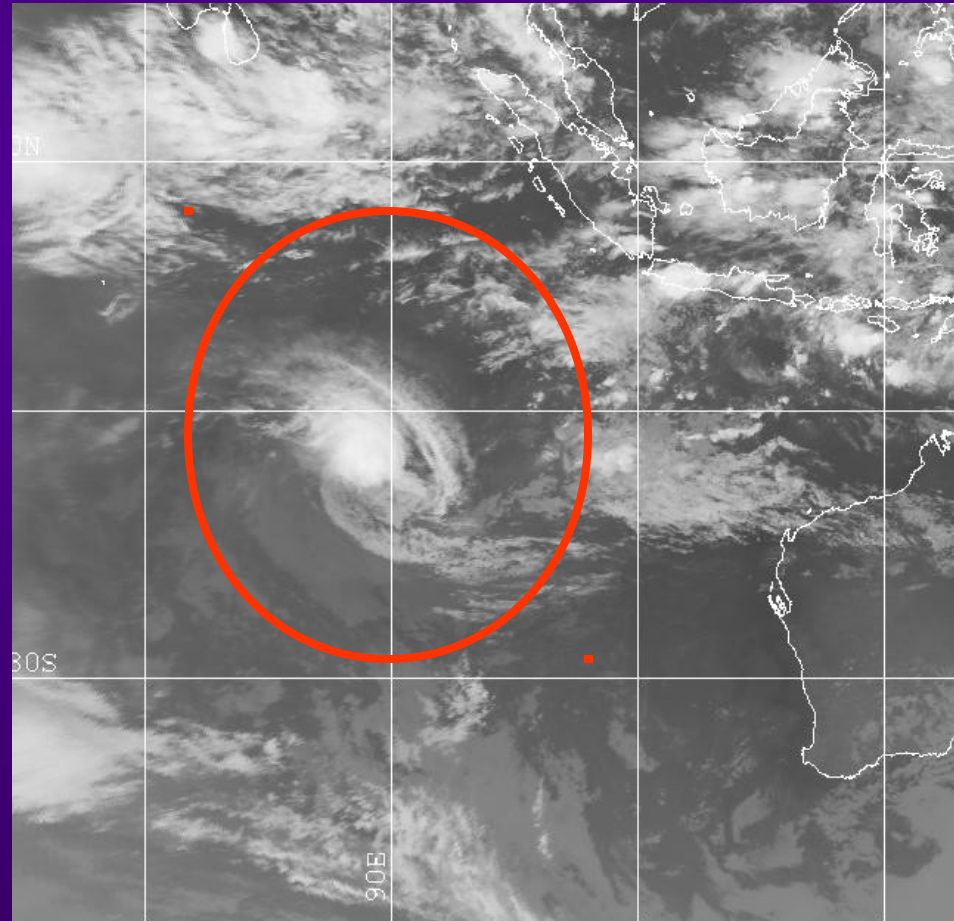


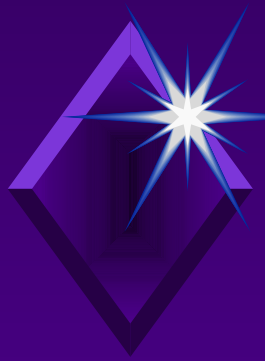


TROPICAL STORM *(Immature to Mature* *Stage)*

TROPICAL STORM FREDRICKA

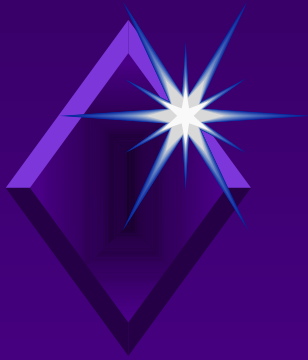
- ◆ winds 34 - 63 kts
- ◆ closed formation expands with **spiral bands becoming better organized**
- ◆ **increasing sea state** makes navigation near the center increasingly difficult and dangerous





HURRICANE (Mature Stage)

- ◆ winds > 63 kts sustained
- ◆ **DANGEROUSLY HIGH SEAS** severely impairs navigation
- ◆ radius of strong winds may exceed **350 nm**
- ◆ Gale Force Winds extend out further in **right front quadrant** (typically 120 nm)



TROPICAL CYCLONE DISSIPATION

A. Recurvature:

- ◆ storms curve back east, usually accelerate, decrease in strength, but increase in diameter.

B. Frictional Forces of Land - takes away energy source/shears apart (mountainous islands)

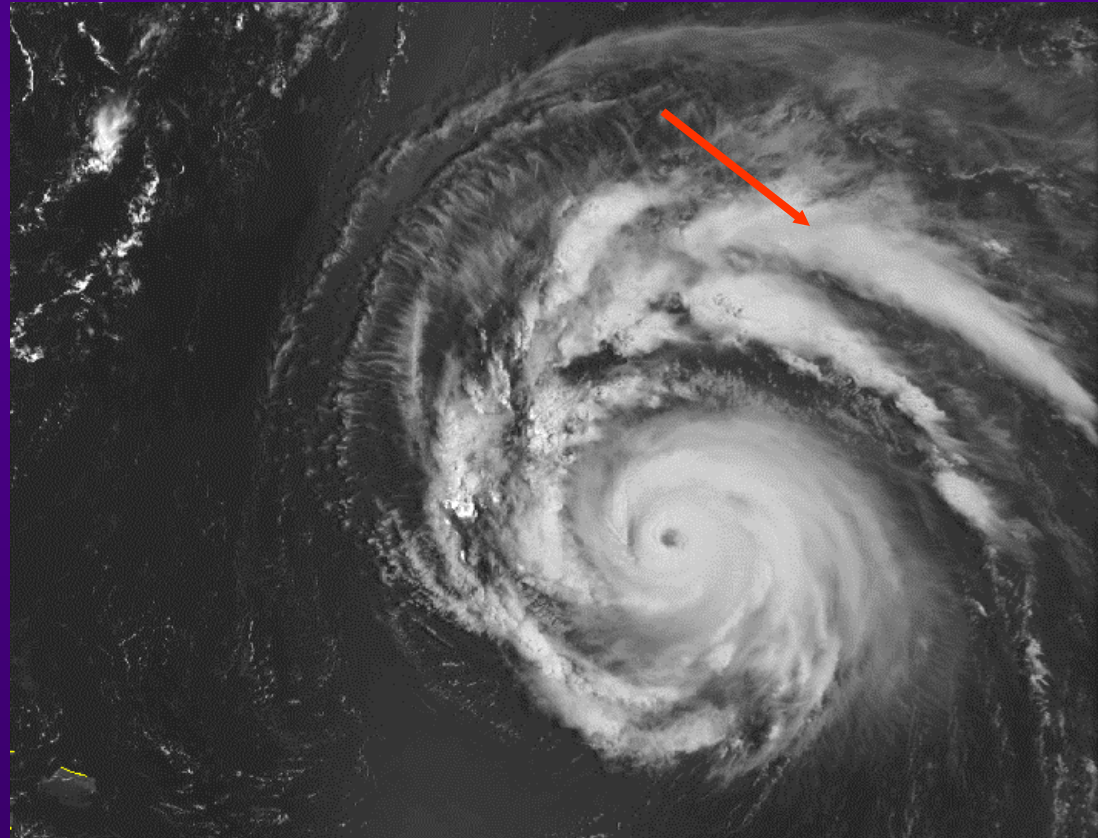
C. Unfavorable atmospheric/oceanographic Influences:

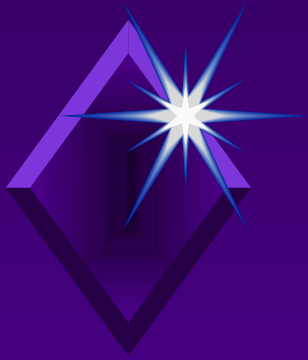
- ◆ shearing, other Tropicals, etc...
- ◆ upwelling in wake



TROPICAL CYCLONE CHARACTERISTICS

Feeder Bands (curved lines of convection) spiral inward to the Eye Wall. Some of the most violent weather (tornadoes/severe thunderstorms) occurs in these areas.



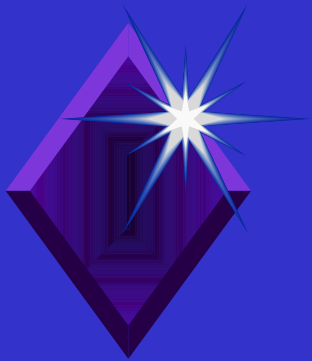


TROPICAL CYCLONE CHARACTERISTICS

Storm Surge:

Abnormal rise of the sea in advance/with the cyclone formed by the cyclone's onshore winds to the right of the cyclone center and low pressure near the cyclone's center. "WALL OF WATER"
Plus or minus tides.

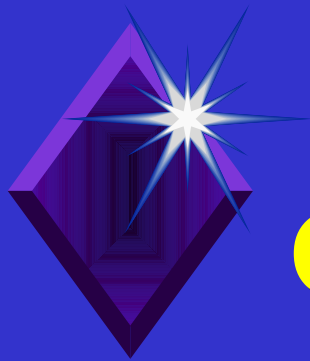
Reported 23 foot storm surge with Camille.



HURRICANE CATEGORIES

SAFFIR - SIMPSON SCALE

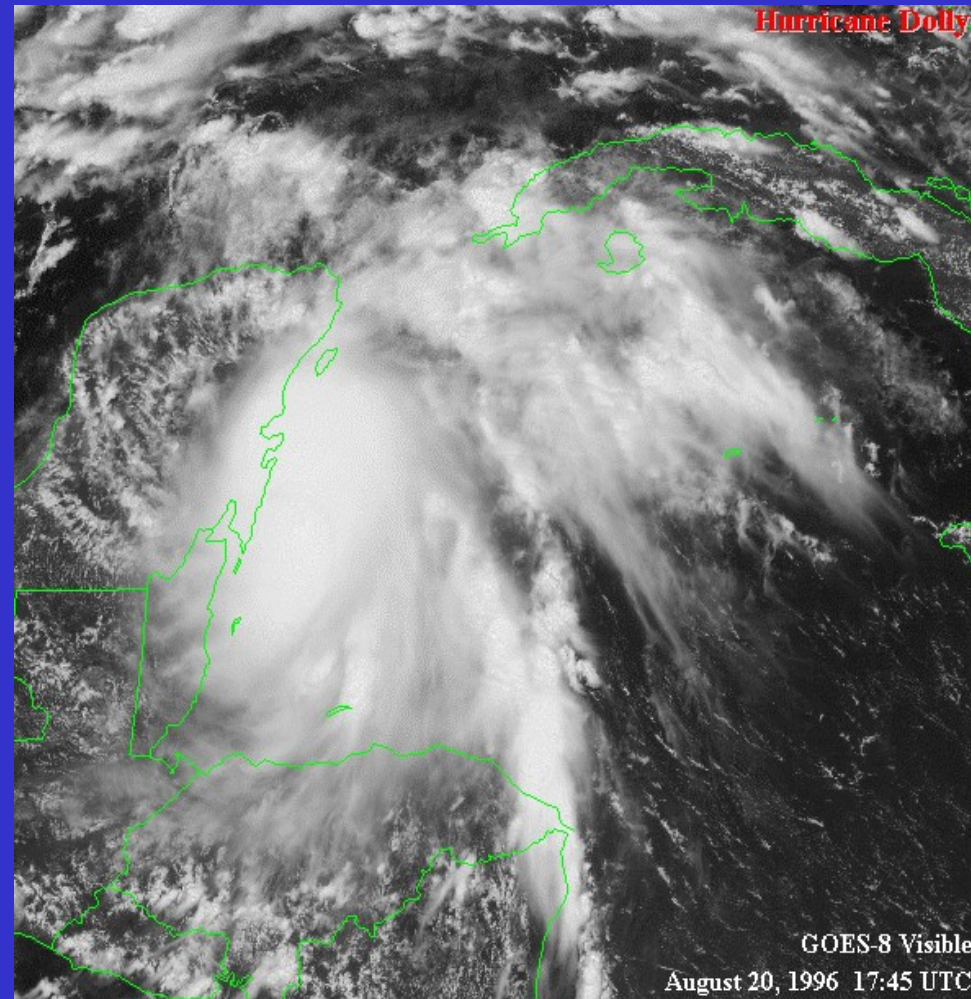
Predicts potential hurricane damage based on the amount of storm surge and wind speed. The severity of damage is dependent on hurricane's angle of approach and bathymetric slope of the coastline. Most dangerous when coincident with high tides.



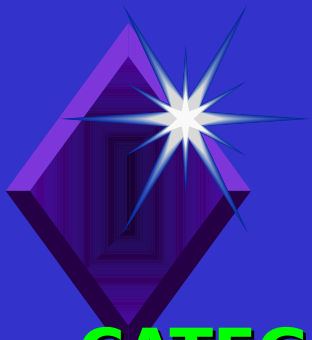
HURRICANE CATEGORIES

CATEGORY I (Minimal)

**Winds 65 - 82 kts,
storm surge 4 - 5 ft
above normal
water level. No
major damage is
expected to most
buildings. Low
lying coastal areas
flooded, minor
damage to piers.
(DOLLY 1996)**

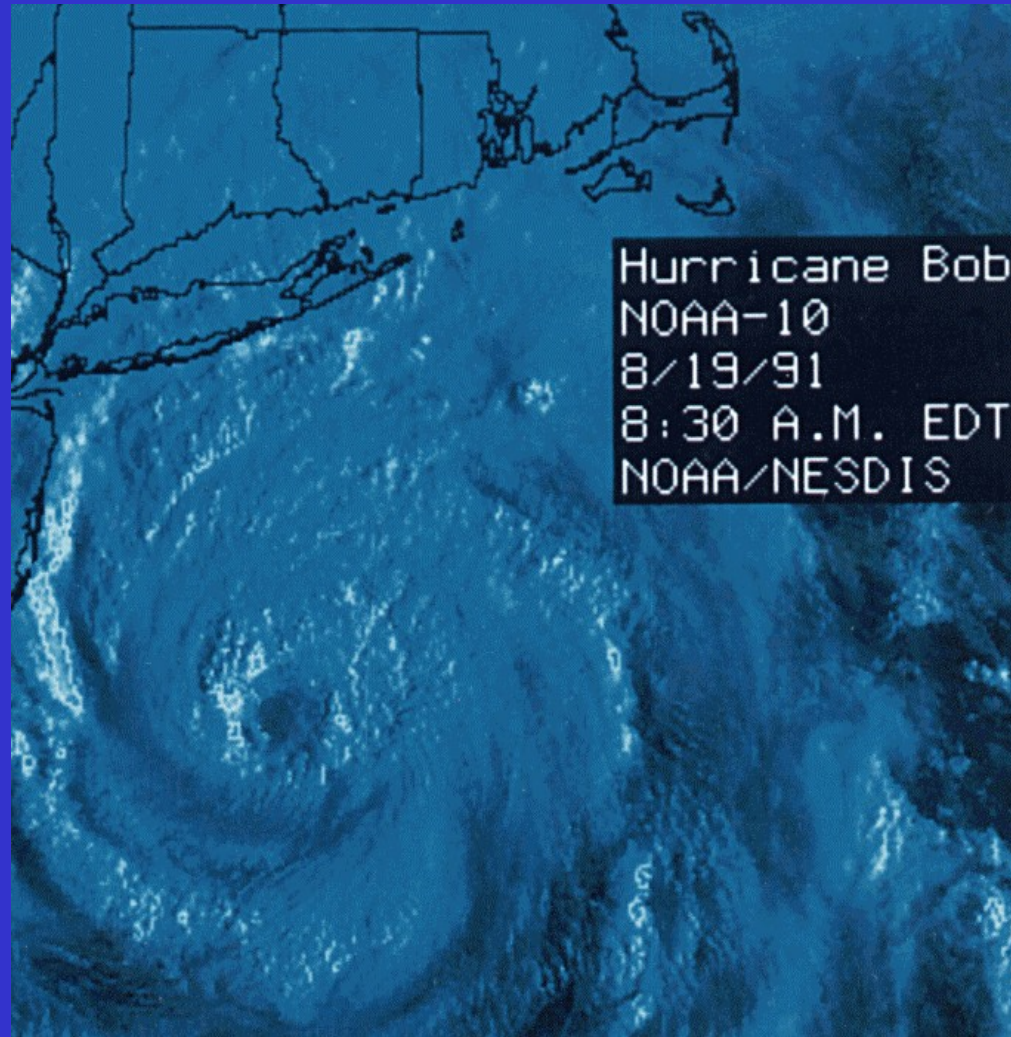


HURRICANE CATEGORIES

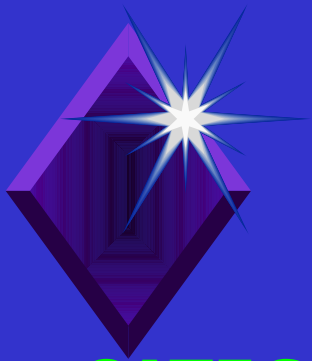


CATEGORY II (Moderate)

**Winds 83 - 95 kts,
storm surge 6 - 8 ft
above normal.
Major damage to
poorly constructed
buildings. Coastal
and low lying
escape routes flood
over, considerable
pier damage.
(BOB 1991)**



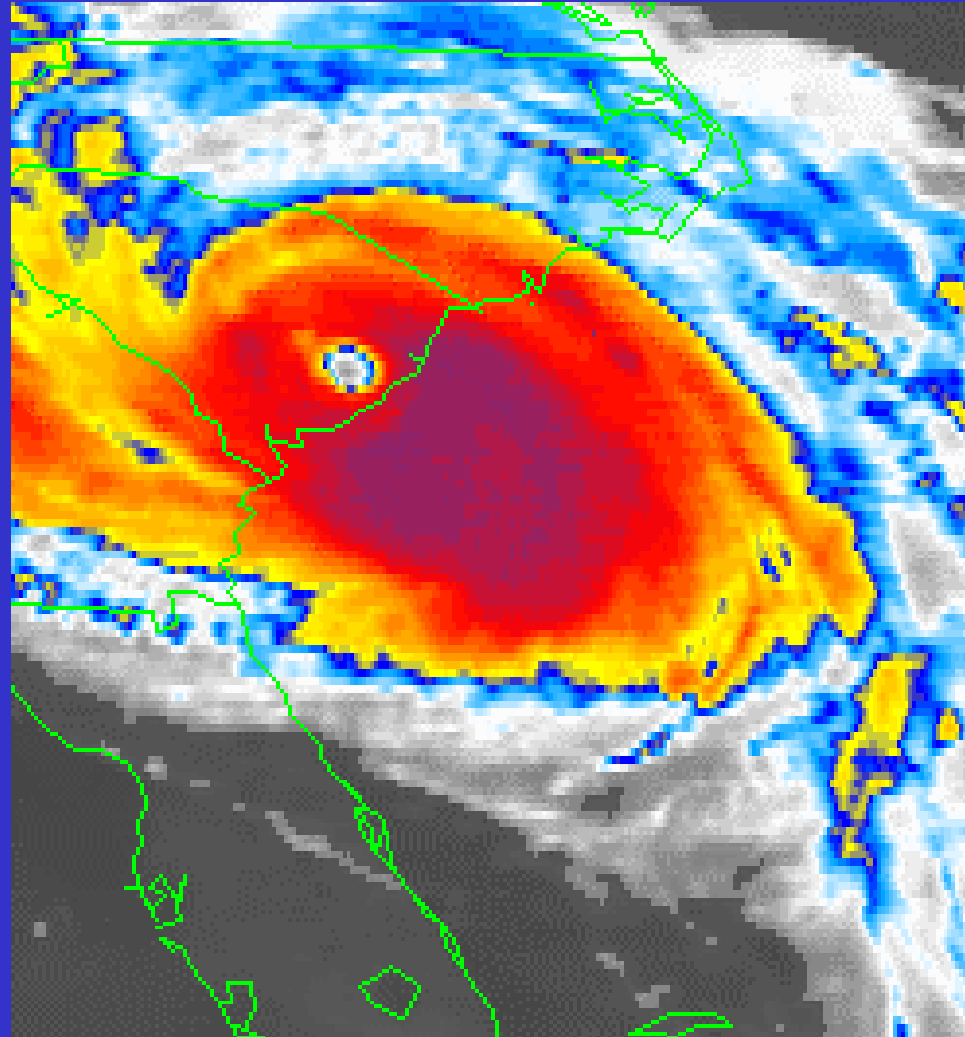
HURRICANE CATEGORIES



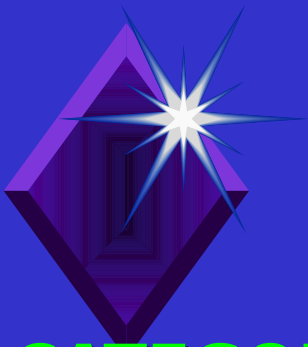
CATEGORY III (Extensive)

Winds **96 - 113 kts**,
storm surge **9 - 12 ft.**

Major damage to
most
structures, poorly
constructed
buildings
destroyed.
Extensive
flooding along the
coast may extend

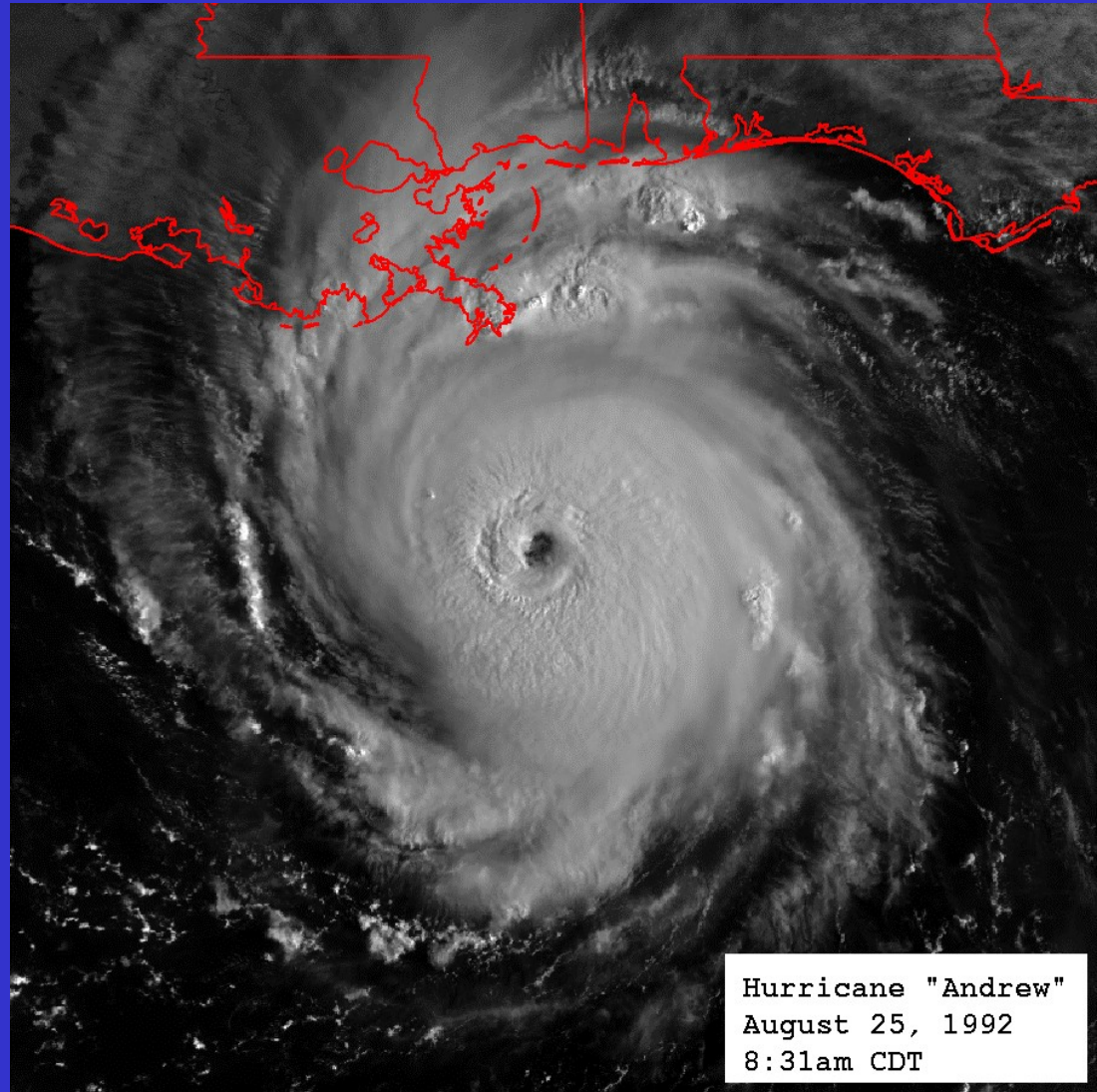


HURRICANE CATEGORIES

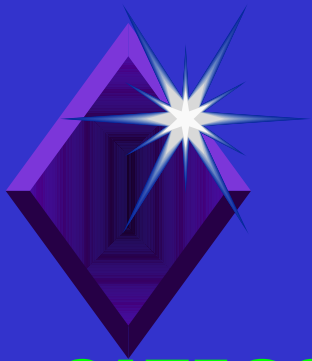


CATEGORY IV (Extreme)

Sustained winds of **113 - 135 kts**, storm surge **13 - 18 ft** above normal. Extensive roof and window damage. Complete destruction of mobile homes. Major erosion of beaches and massive evacuation of low lying



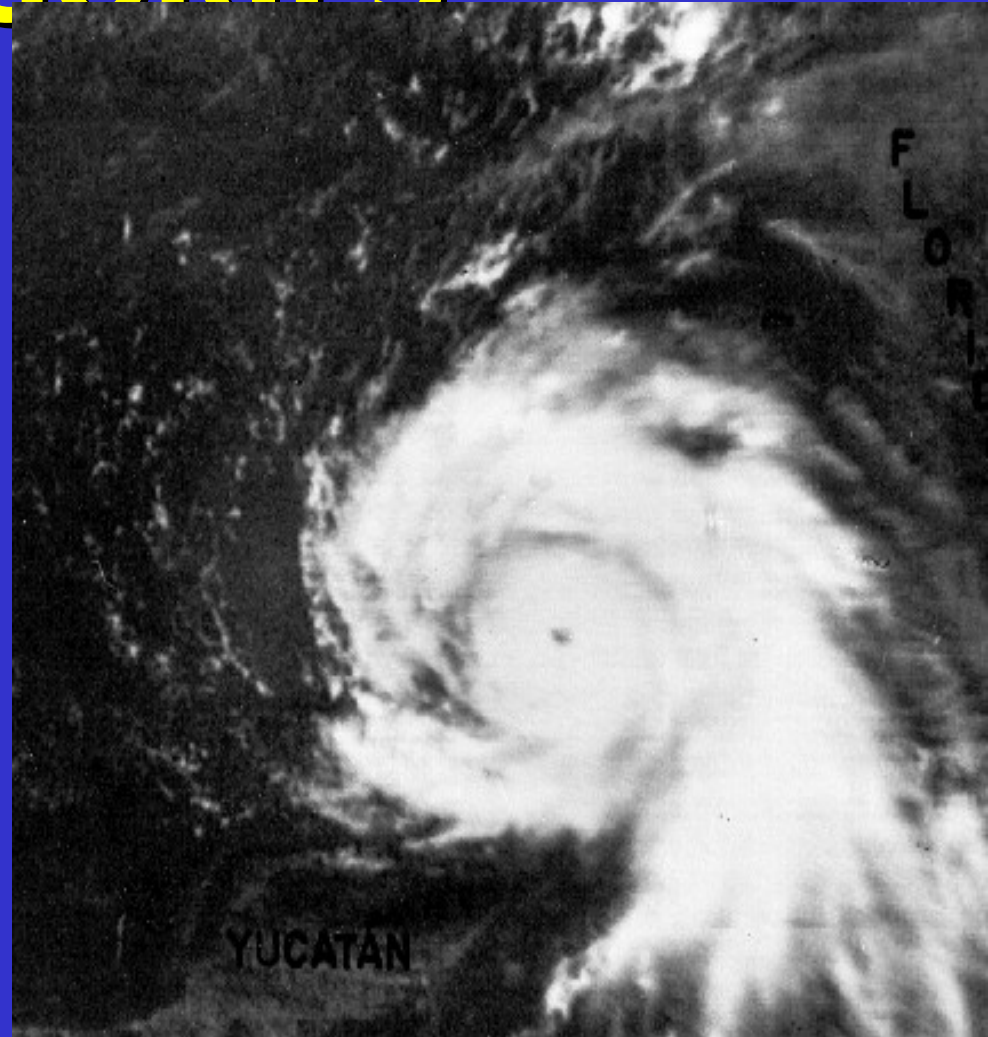
Hurricane "Andrew"
August 25, 1992
8:31am CDT

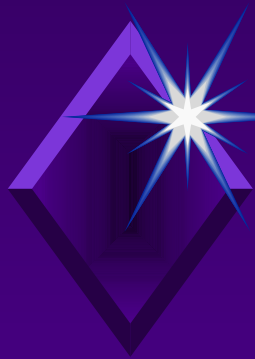


HURRICANE CATEGORIES

CATEGORY V (Catastrophic)

Winds above 135 kts, storm surge greater than 18ft above normal. Failure of roof structures, severe window and door damage, some buildings fail. Major structural damage inside the surge flood zone. Massive evacuations of low lying coastal areas.





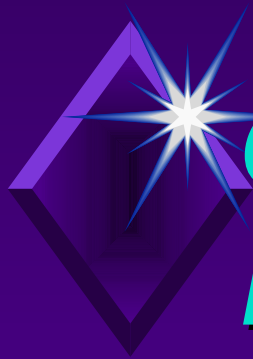
TROPICAL CYCLONE CONDITIONS OF READINESS

CONDITION V - Normal condition of readiness set during hurricane season 01 June to 30 November.

15 May to 30 November for EPAC.

CONDITION IV - Destructive force winds (50 kts or greater) expected within 72 hours.

*** *DESTRUCTIVE FORCE WINDS ARE DELINEATED BY
LOCAL 3140 INSTRUCTION***



CONDITIONS OF READINESS

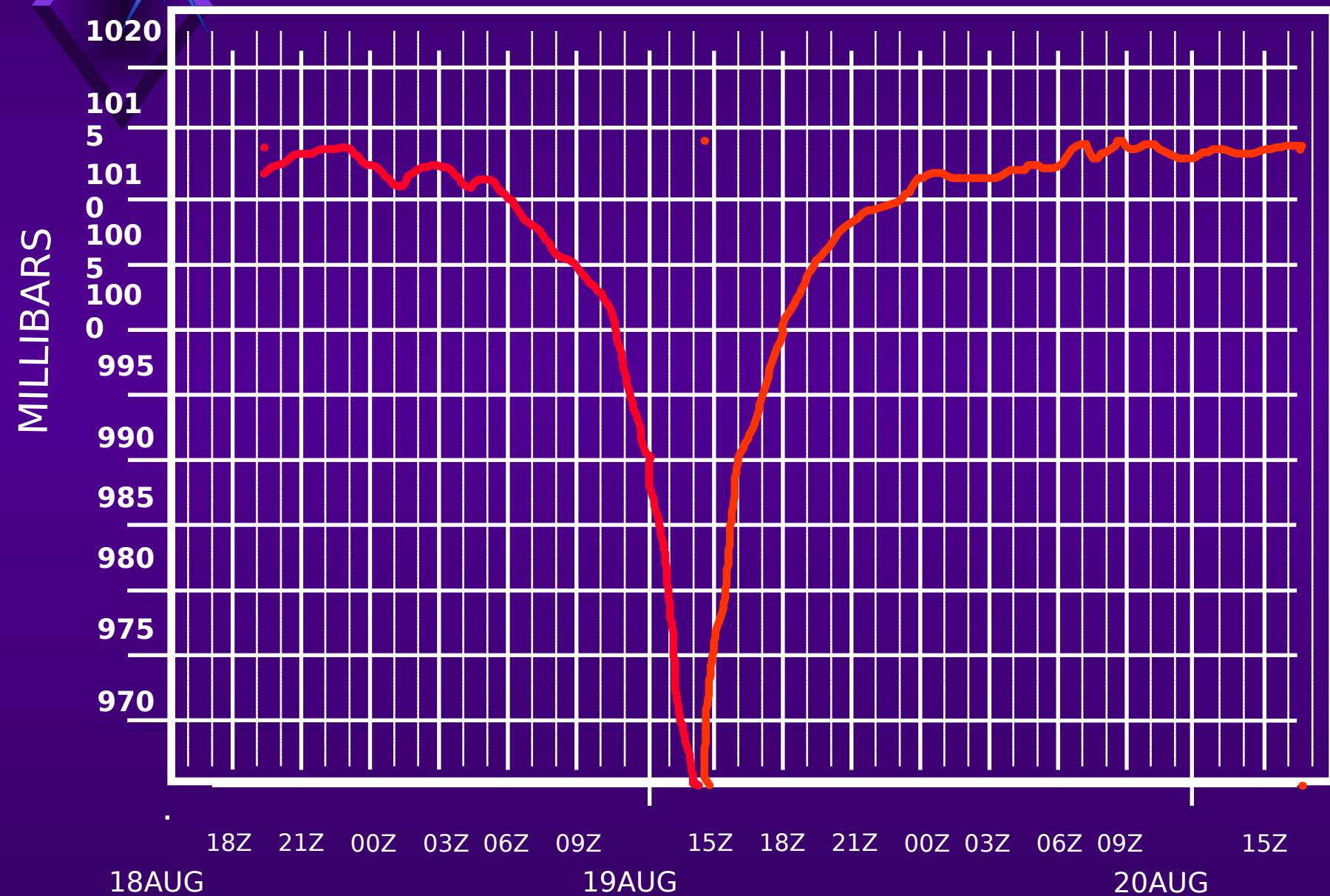
CONDITION III - Destructive force winds are expected within 48 hours.

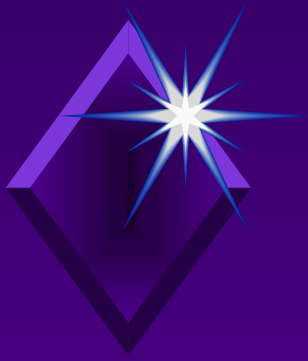
CONDITION II - Destructive force winds are expected within 24 hours.

CONDITION I - Destructive force winds are an ***imminent threat*** within 12 hours.

BAROGRAPH TRACE

Hurricane Bob 1991 NLMOD Newport



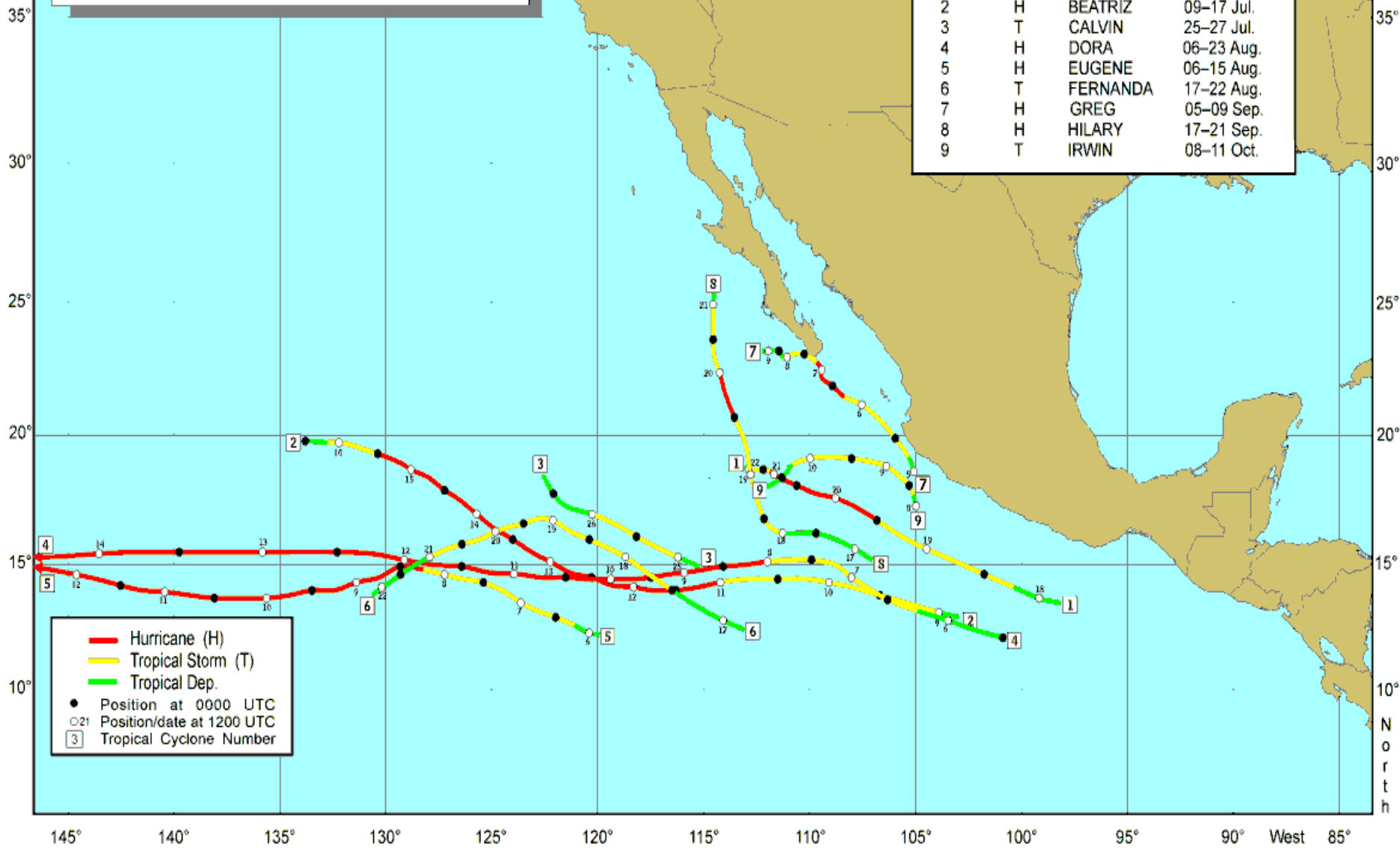


EPAC
HURRICAN
ESTORM
TRACKS

145° 140° 135° 130° 125° 120° 115° 110° 105° 100° 95° 90° 85°

NATIONAL HURRICANE CENTER EASTERN PACIFIC HURRICANE TRACK CHART

| NUMBER | TYPE | 1999 NAME | DATE |
|--------|------|--------------|------------|
| 1 | H | ADRIAN | 18-22 Jun. |
| 2 | H | BEATRIZ | 09-17 Jul. |
| 3 | T | CALVIN | 25-27 Jul. |
| 4 | H | DORA | 06-23 Aug. |
| 5 | H | EUGENE | 06-15 Aug. |
| 6 | T | FERNANDA | 17-22 Aug. |
| 7 | H | GREG | 05-09 Sep. |
| 8 | H | HILARY | 17-21 Sep. |
| 9 | T | IRWIN | 08-11 Oct. |





MONITORING THE STORM

- ◆ NPMOC JTWC/TPC/CPHC
Warnings/Bulletins
- ◆ Joint Maritime Command Information
System (JMCIS) **METOC Overlays**
- ◆ Satellite Imagery
- ◆ Weather Channel



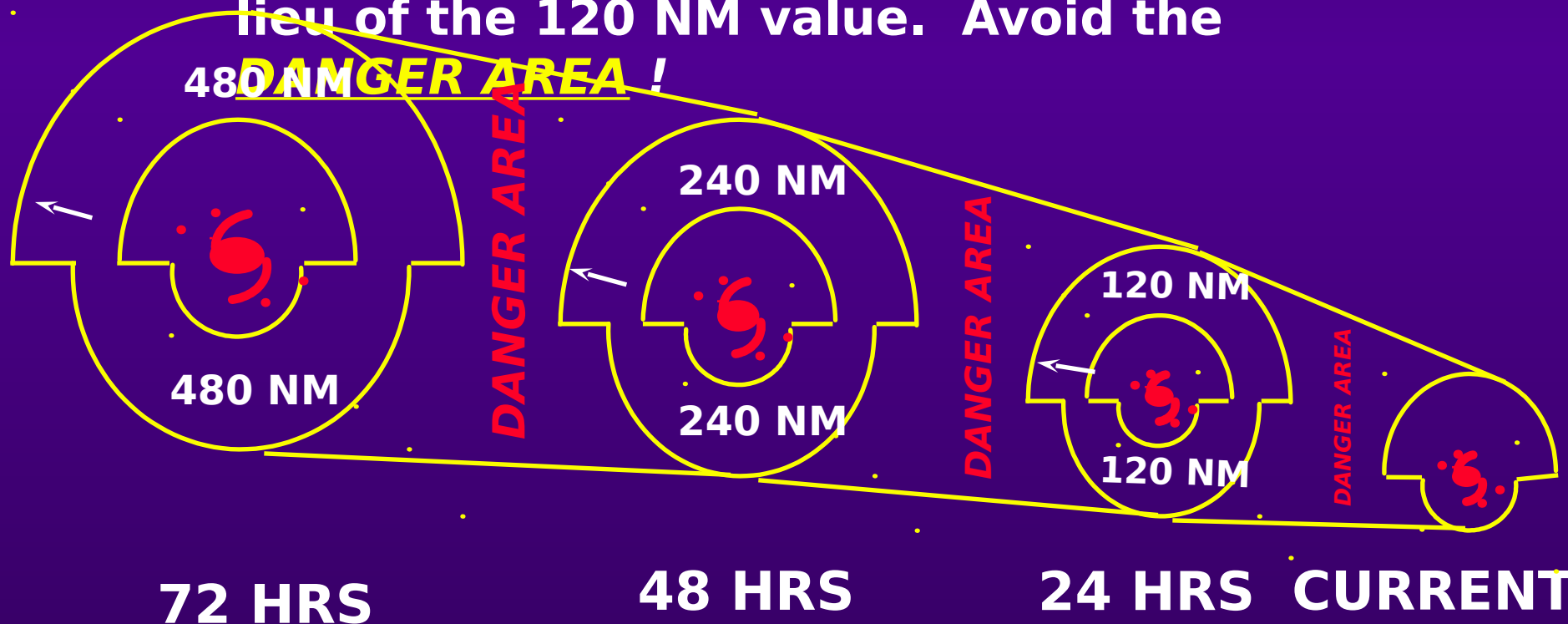
WARNINGS

- ◆ **Frequency** (every 6 hours, 03Z, 09Z, 15Z, 21Z)
- ◆ **Methods of Receiving Warning**
 - ★ 1. Autodin addressed to CAD HURRIWARNPAC (regular message traffic)
 - ★ 2. JMCIS
 - ★ 3. NPMOC San Diego Homepage

UPON RECEIPT OF WARNING

Use the same procedure for the 48 and 72 hr forecast positions as for the 24 hr. Extrapolate out 240 and 480 NM, respectively from the 35 knot wind radii, in lieu of the 120 NM value. Avoid the

DANGER AREA !





TROPICAL CYCLONE EVASION

Cardinal Rule :

Remain far enough away from a Tropical Cyclone

so as to avoid putting a vessel in extremis!



TROPICAL CYCLONE EVASION

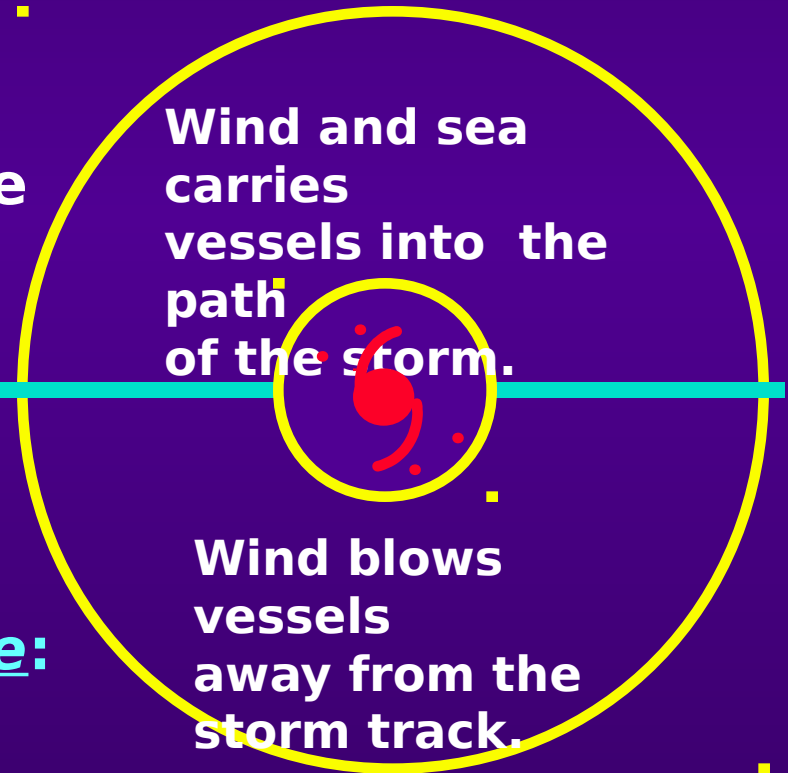
Storm's location relative to own ship's position:

Dangerous semi-circle:

Wind greater due to pressure augmented by the forward motion of the storm.

"Less Dangerous" semi-circle:

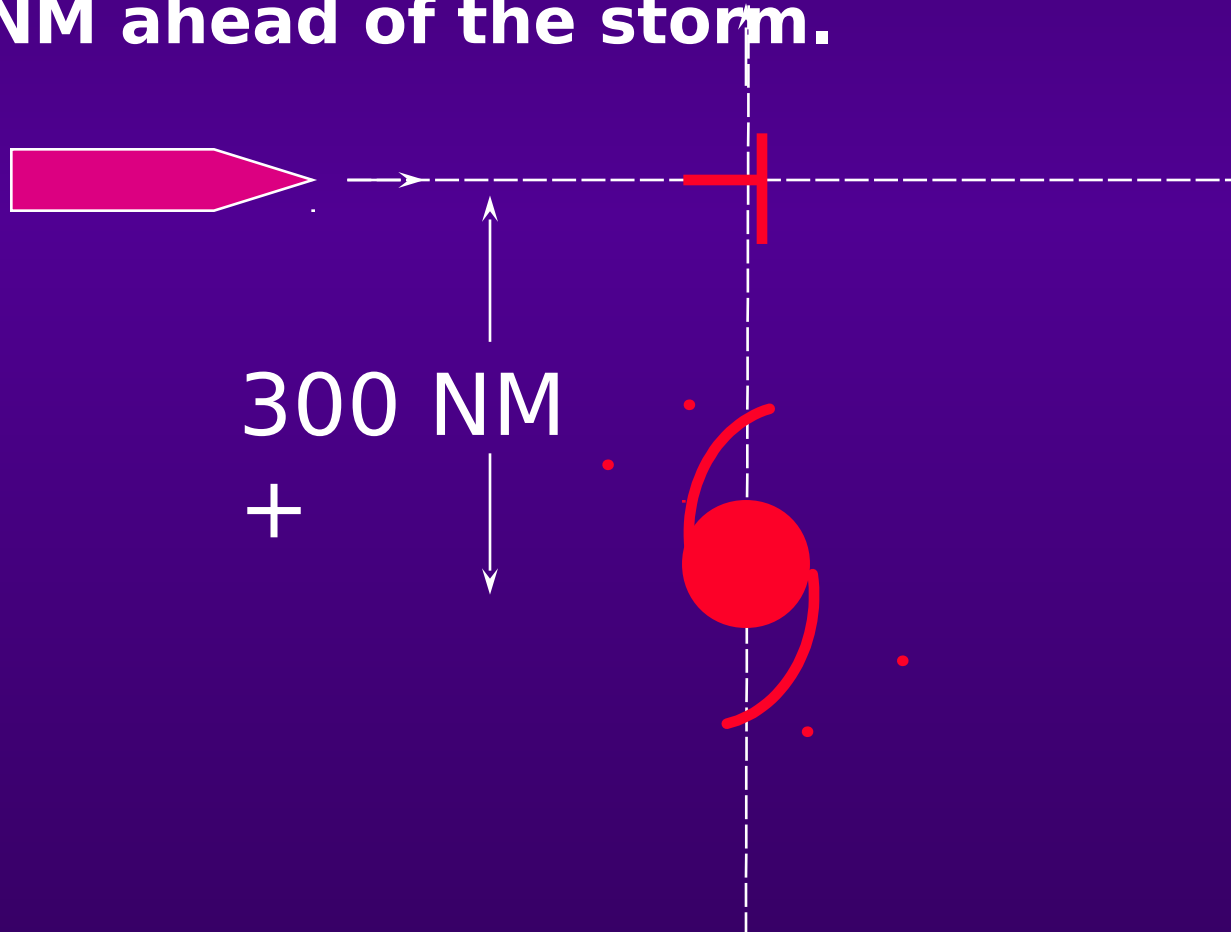
Wind decreased by forward motion of the storm.





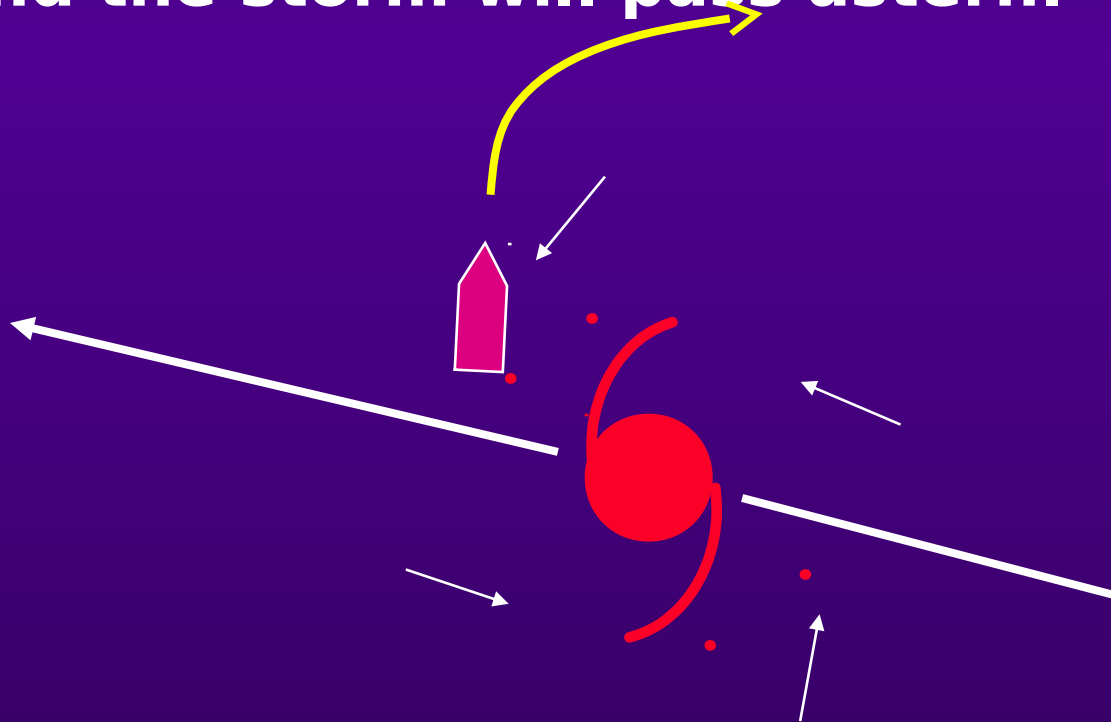
TROPICAL CYCLONE EVASION

DO NOT CROSS THE "T" unless the ship is
> 300 NM ahead of the storm.



TROPICAL CYCLONE EVASION

Dangerous Semicircle: Place wind on the starboard bow and hold it. If the wind veers, you are in the dangerous semi-circle and the storm will pass astern.

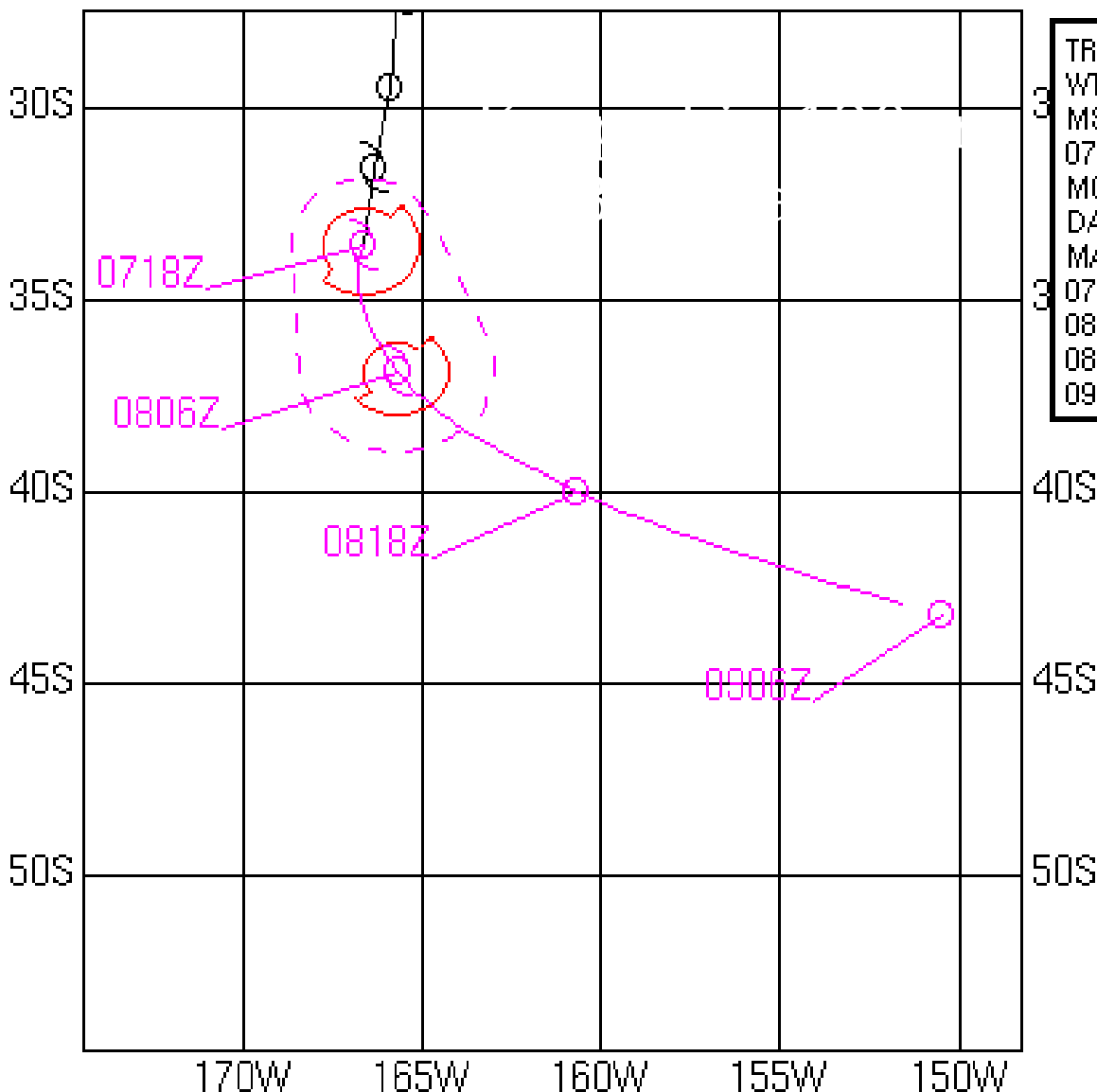


TROPICAL CYCLONE EVASION

Less Dangerous Semi-circle: Place wind on the starboard quarter and hold it. If the wind backs, you are in the less dangerous semi-circle and the storm will pass astern.



TROPICAL CYCLONE 18P (LEO) WARNING #03



TROPICAL CYCLONE 18P (LEO) WARNING #3
WTPS 31 PHNC 072100
MSGDTG: NPMOC 071953Z MAR 00
071800Z POSIT: 33.6S 166.6W
MOVING 185 DEGREES TRUE AT 20 KNOTS
DASHED LINE INDICATES 24-HOUR DANGER AREA
MAXIMUM SEAS: 14 FEET.
0718Z, WINDS 035KTS, GUSTS TO 045KTS
0806Z, WINDS 035KTS, GUSTS TO 045KTS
0818Z, WINDS 030KTS, GUSTS TO 040KTS
0906Z, WINDS 025KTS, GUSTS TO 035KTS



- ◆ **Western North Pacific: Typhoon**
- ◆ **Australia: Willy willy**
- ◆ **Philippines: Baguio**
- ◆ **India: Cyclone**



PACIFIC HURRICANE

Aletta

Willa

Bud

Xavier

Carlotta

Yolanda

Daniel

Zeke

Emilia

Fabio

Gilma

Hector

Ileana

John

Kristy

NAMES 2000

Lane

Miriam

Norman

Olivia

Paul

Rosa

Sergio

Tara

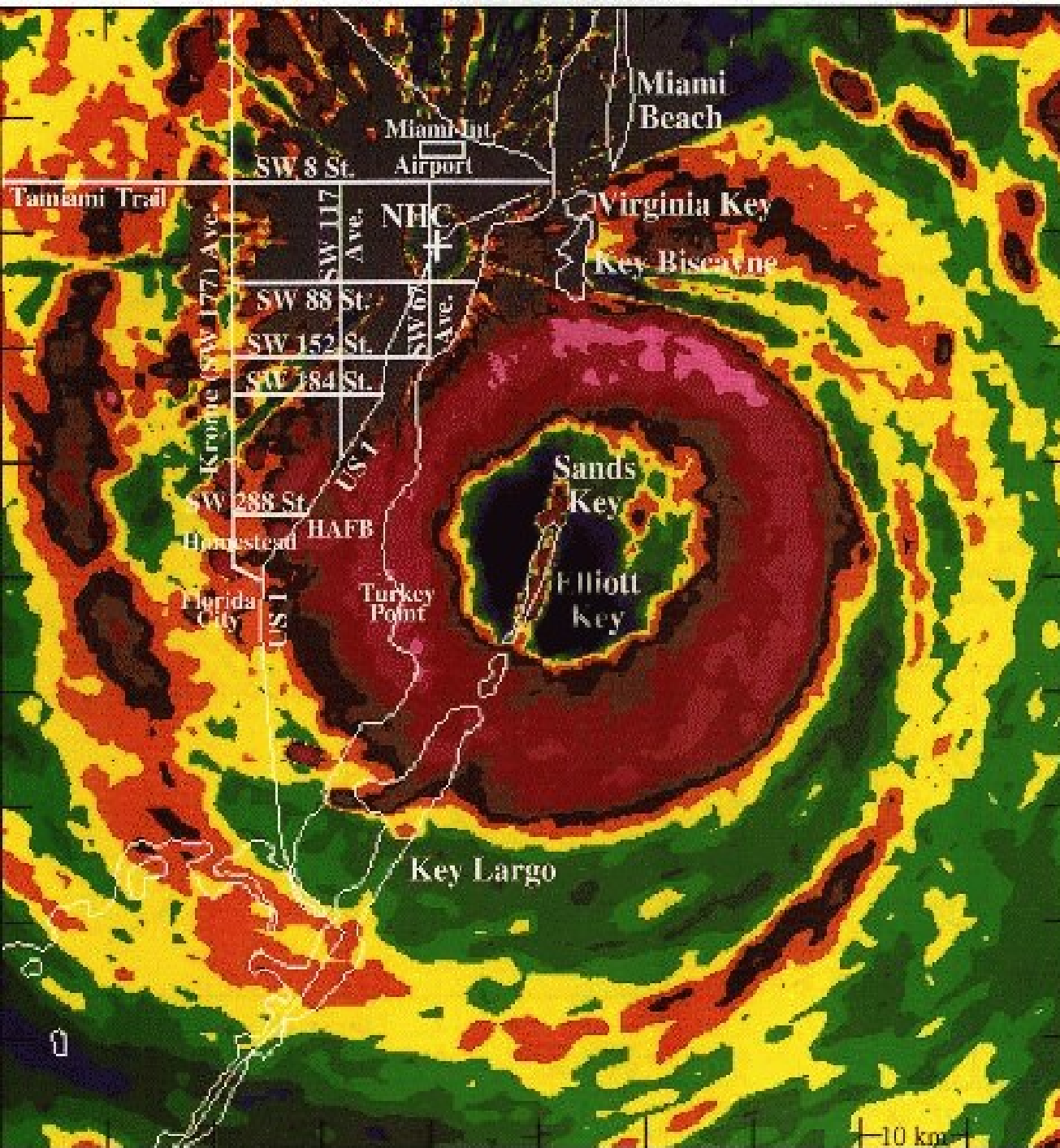
Vicente

HURRICANE ANDREW

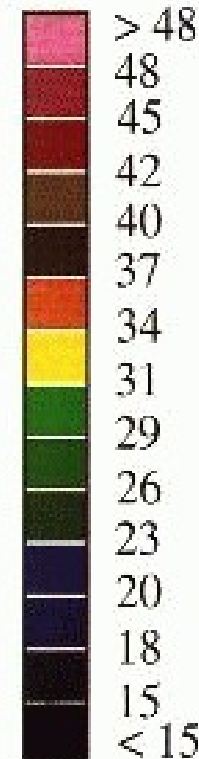
NWS MIAMI RADAR

August 24, 1992

08:35 UTC 04:35 EDT



dBZ



Hurricane
Research
Division

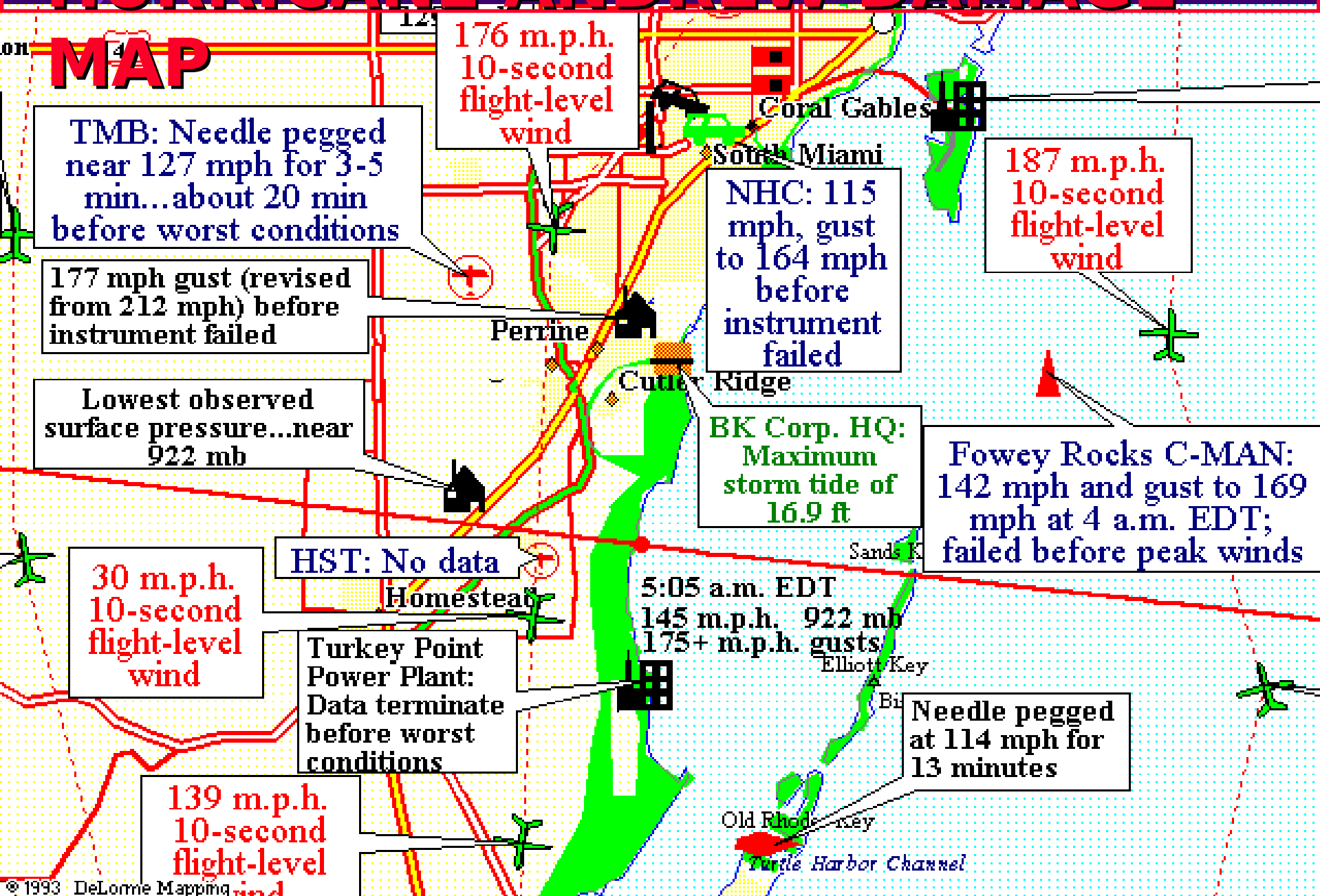


NOAA/AOML
Miami, FL

Domain: 100 x 100 km

HURRICANE ANDREW DAMAGE

MAP



G8 VIS 13 MITCH 10/25/98 2145Z NRL Monterey Code 7541
Sun elevation= 13 degrees

The end!

HURRICANE MITCH CAT 5

